Chapter 2
Field Organization and Responsibility

2-1. Resident Inspection Force

Each levee, earth or rock-fill dam, or other embankment must be adequately inspected to ensure that plans and specifications are observed and followed by the contractor. This requirement applies to all divisions and districts having responsibility for design and construction of civil works projects. The size and composition of the resident inspection force for foundation and earthwork control operations should be adequate to provide for continuous inspection of construction activities, field testing and sampling, observation of field instrumentation, laboratory testing, data compilation, maintenance of records, and preparation of reports. On large projects, the contractor may operate as many as three shifts, and materials-handling for fill operations may be highly mechanized to obtain high production. The inspection force must be so staffed and organized that inspectors and technicians are available for continuous inspection of the contractor's operations. In discussing contractor quality control, ER 1180-1-6 states, "The Government is responsible for all phases of the construction project, including the activities necessary to assure that the contractor has complied with the requirements of the contract plans and specifications..." and "In contrast to the Contractor's quality control the government is responsible for quality assurance. This includes checks, inspections, and tests of the products which comprise the construction, the processes used in the work and the finished work for the purpose of determining whether the Contractor's quality control is effective and he is meeting the requirements of the contract. These activities are to assure that defective work or materials are not incorporated in the construction."

a. Technical responsibilities. The Resident Engineer is responsible for constructing the embankment and related appurtenances in compliance with plans and specifications. On large projects, resident geologists and soils engineers provide technical assistance. Assisting the Resident Engineer are office and field engineering staffs. The office engineering staff is responsible for preparing field modifications to the plans and specifications in accordance with applicable district regulations, reviewing plans submitted by the contractor such as those for quality control and dewatering, evaluating results of construction control tests, and compiling instrumentation data to send to the Engineering Division for evaluation. The field engineer in charge of field supervision and inspection is responsible for planning, executing, and coordinating all field inspection and testing to ensure compliance with established standards and detail drawings and specifications. The field engineer is assisted by one or more chief construction inspectors on each shift who coordinate the activities of subordinate inspectors, and by a materials testing or soils engineer who supervises a number of technicians in obtaining samples and performing required field and laboratory tests. Detailed technical and organizational responsibilities may differ in the various districts and divisions; however, construction projects are to be staffed with the number of experienced Government laboratory technicians needed to perform Government acceptance testing on compacted fill, including filter and drainage fills. Acceptance testing should be performed immediately after placement and compaction of the lift material to be sampled and tested. Attention should be given to selection of samples for acceptance testing so that all materials of generally different descriptions being placed in the same compacted zone of the embankment will be tested.

b. Preconstruction training. Every earth or rock-fill dam is designed for specific foundation conditions and to utilize locally available materials. Unique features are inherent in each project, and a wide variety of construction methods may be utilized. Therefore, good communication between design and construction personnel is essential. The construction staff should be familiar with the design memoranda pertinent to the work. Preconstruction instructions and training should be given to field inspection personnel to acquaint them with the design concepts and to provide them with a clear understanding of expected conditions, methods of construction, and the scope of plans and specifications. This may be done by training sessions, preferably with design personnel present, using a manual of written instructions prepared especially for field personnel, to discuss engineering considerations involved and to explain control procedures and required results. Inspection personnel should be familiar with the plans and specifications; excavation boundaries; types of materials to be excavated; temporary and permanent drainage and seepage control measures; approved sources of borrow materials; procedures and equipment most suitable for excavating, processing, and hauling borrow materials; characteristics of fill materials and compaction requirements; capabilities of various types of compaction equipment; and procedures required to obtain desired or specified compaction. Closely supervised on-the-job training should be given to inspectors and materials testing personnel during initial stages of construction to increase their proficiency in recognizing signs of inadequate compaction, in using expedient methods of checking water content and density of fill materials, in using selected methods for field density measurements and

laboratory compaction, and in detecting inadequate construction procedures and unsafe conditions.

c. Number of personnel and skills required. Experienced construction engineers, inspectors, and technicians are required for construction control operations on earth and rock-fill dams. The Resident Engineer, the field engineer in charge of supervision and inspection, chief inspector, materials engineer or chief soil technician, and geologists should have been associated with the project from the time of any preliminary construction operations such as test fills, quarry blasting and rock production tests, and excavations of tunneling made to inspect subsurface conditions. Augmentation of this cadre with less experienced inspectors and technicians will provide a sufficiently capable inspection force. An example of a resident inspection force organization for a large earth and rock-fill dam is shown in Figure 2-1. Additional inspectors and technicians may be required during certain phases when construction operations are at their peak or when several major portions of the earth or rock-fill dam are being constructed concurrently. An example of a typical similar organization for a smaller earth dam project is shown in Figure 2-2. It should be noted that the organization for a small earth dam is very flexible, being dependent on the magnitude and extent of the construction. Small projects often require temporary assignment of specialized personnel, such as soils engineers and geologists, during certain construction phases.

d. Quality control.

(1) The contractor is responsible for quality control, and the contract specifications give requirements for the contractor quality-control organization, personnel qualifications, facilities and types of tests, and reporting of test data and inspections. The Government field inspection force has the responsibility of accepting completed work and must have a staff large enough to accomplish the following:

(a) Check the effectiveness and adequacy of the contractor's quality-control system and take action to have deficiencies corrected.

(b) Inspect construction operations to prevent defective work and placement of unsatisfactory materials.

(c) Monitor progress.

(d) Perform check tests and acceptance tests.

(e) Resolve or report field problems and conflicts with contract documents to higher authority.

(f) Make acceptance inspections.

(2) Contractor quality-control operations will, if properly implemented, assist in achieving adequate construction,

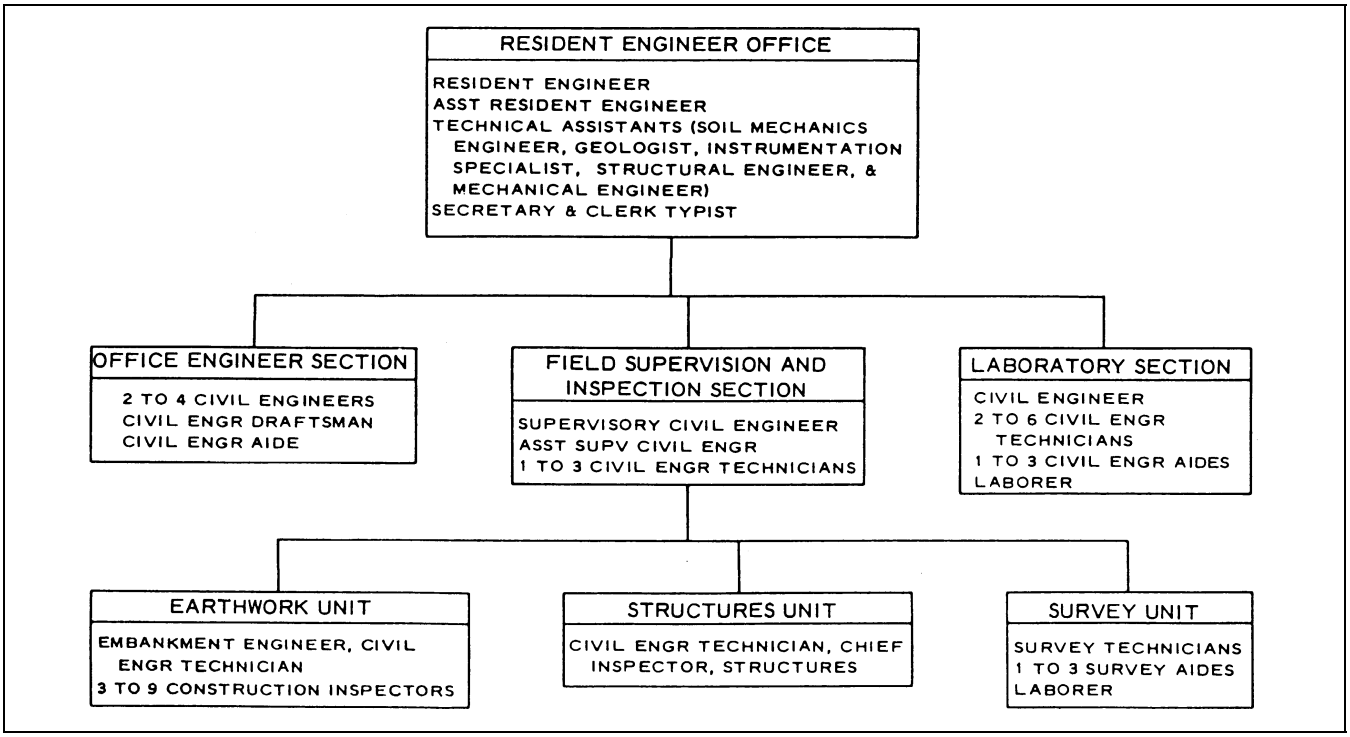

Figure 2-1. Example of resident engineer's staff organization for large earth dam project

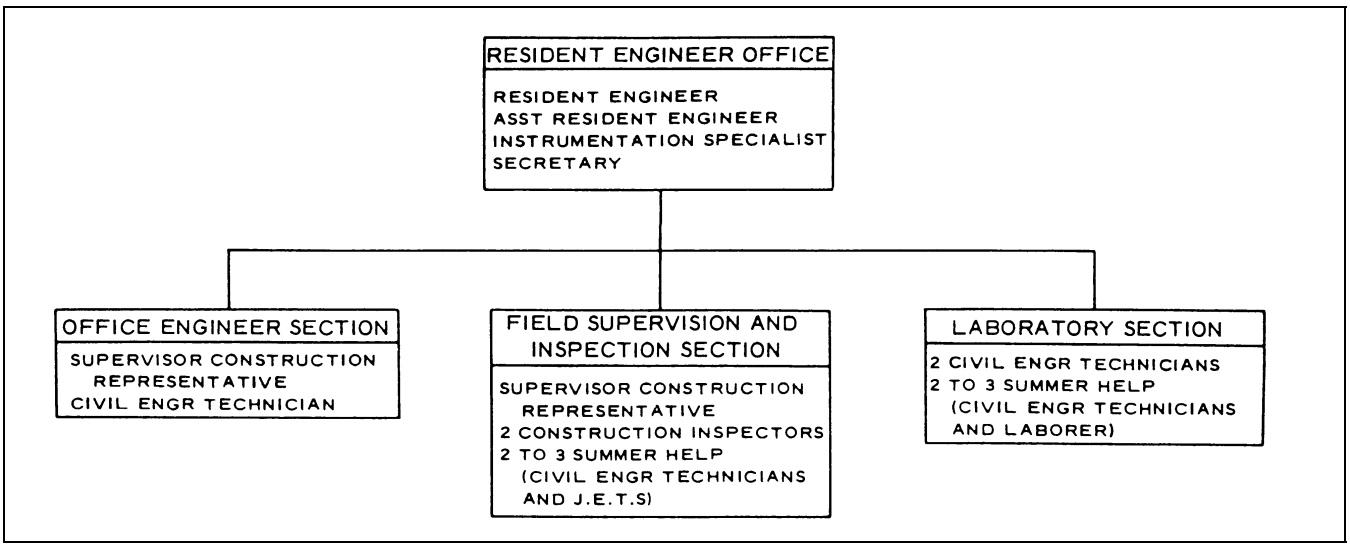

Figure 2-2. Example of resident engineer's staff for small earth dam project

particularly on those operations where specifications contain product requirements such as water content limits and gradation of filter material. However, Government field inspectors must be present to witness operations for which construction procedures are specified and to conduct tests to ensure that results obtained are those required by design. Several important considerations are listed below:

(a) The contractor is not required to conduct tests on the quality or durability of materials used for pervious fill, filter zones, bedding, spalls, or rip-rap. The Government is responsible for determining such properties in approving sources of natural or processed (blasted, ripped, or crushed) pervious materials for use in embankments.

(b) The contractor is not required to provide tests on compaction characteristics when fill placement procedure is specified. Government inspection forces are responsible for inspecting the contractor's specified construction activities and for testing embankment or slope materials to establish that excavation and fill placement procedures result in an excavated slope or fill that conforms to properties assumed in the design.

e. Relationship with contractor. Mutual understanding between the Resident Engineer and his staff and the contractor of the requirements of the contract specifications is necessary to obtain desired construction quality. The quality of the work must never be compromised. Unnecessary requirements and restrictions should not be imposed over and above the specification requirements. Firmness by Resident Engineers and inspectors who are efficient and know their job will gain the respect and cooperation of the contractor.

2-2. Field Laboratory

Foundation and earth-fill materials are tested in the field laboratory to determine gradation, water content, in situ density, compaction, relative density, and Atterberg limits. The data obtained serve as a basis for ensuring compliance with specifications and design requirements, for guidance toward maximum utilization of available materials, and for providing a record of the properties of materials placed in all parts of the project.

a. Size. The size of the field laboratory and satellite testing units depends on the magnitude and areal extent of construction operations. Remote borrow areas, dikes, or relocation fills may require a central laboratory, supplemented by one or more skid- or wheel-mounted portable units. An existing structure, a prefabricated structure, or trailer may be specified. For relatively large projects, about 500 to 1,500 sq ft may be required for a laboratory space. The laboratory should have a sound floor, necessary worktables, benches, storage cabinets, equipment pedestals (for compaction mold base and sieve shakers), service sinks, and utilities. Additionally, it may be very advantageous to have an awning-covered work slab with an area of from 500 to 1,000 sq ft to serve as a work space on which to dry and work large samples, to perform coarse aggregate gradations, etc.

b. Types of tests and facilities required. The major portion of testing in the field laboratory is for acceptance testing of compacted fill. These tests must be conducted in a manner that will yield results of a quality comparable to the initial laboratory tests upon which the design was based.

Discrepancies resulting from variations in testing equipment and techniques should be carefully avoided. Water content, compaction, relative density gradation, and Atterberg limits tests are the most common tests conducted. Water content and compaction tests are used for control of cohesive soils in impervious and random fills. Atterberg limits tests may be used for control of fills of fine-grained cohesive soils where good correlations of optimum water content and maximum dry density with the Atterberg limits have been established. Gradation and relative density tests are used for control of pervious fills. Gradation tests are also used for control of rock fill. Field density tests are performed on the fill, but compaction tests on the material and water content determinations may be made either in the central laboratory or in the field. The central laboratory must have equipment for these tests, but supplemental portable units may be advisable for gradation, compaction, and water content testing at remote locations. Panel pickup trucks are often used to transport equipment for field density testing, undisturbed (record) sampling in the fill, and sampling in borrow areas. Specially equipped pickup trucks with a small hoist may be required where large-scale field density tests are to be performed on material such as rock fill or soils with a high percentage of large gravel sizes.

2-3. Assistance by Higher Echelon

Unusual conditions encountered during construction generally require special attention. The advice of specialists in soil and rock mechanics, geology, and instrumentation of earth and rock-fill dams, and additional evaluation by design engineers are often required to obtain effective solution to unusual problems and conditions.

a. Geologists and soils engineers. Specialists with experience in soil and rock mechanics, geology, and instrumentation are found in division and district offices, at Headquarters, U.S. Army Corps of Engineers (HQUSACE), Waterways Experiment Station (WES), and on Corps of Engineers boards of consultants. The services of soil and rock mechanics engineers and geologists are particularly valuable during early stages of construction when the foundation, abutment, and any diversion tunnels or excavations (such as for spillway foundations) expose existing conditions. At this time, it is vital that actual conditions be evaluated to determine if they are consistent with conditions assumed for design. In addition, it is necessary to recognize any unusual conditions that may affect construction. The advice of specialists in soil mechanics and rock mechanics is also valuable in establishing, from observed field conditions, modifications that may significantly improve the design without increasing the cost of the project.

b. Design engineers. The engineer who designs the earth or rock-fill dam should visit the project during construction and assist field personnel in interpreting plans and specifications and observe problems that may not have been fully evaluated in the design. Visits should also be made whenever unexpected conditions are encountered that may require changes in the plans or specifications. A cooperative attitude must be maintained between design engineers and construction personnel so that mutual understanding is reached on existing problems and feasible solutions are developed. In some cases, conferences at the construction site may be necessary between construction personnel, designers, and specialists to review conditions and determine if design modifications are required. A regular schedule of visits should be set up so that design personnel and representatives from the division office and HQUSACE can inspect field conditions at critical construction stages.

c. Instrumentation. Instrumentation of earth and rock-fill dams is becoming increasingly important. The main reasons are that many higher earth and rock-fill dams are being constructed, sites having unfavorable foundation conditions must be used more frequently, interest is increasing in obtaining meaningful data for evaluating dam behavior, and continually increasing downstream land development is increasing the consequences of failure on property damage and loss of life. Monitoring of pore water pressure, settlements, and deformations of the foundation and embankment is necessary to check the safety of the dam during construction and to control the rate of construction. The instrumentation must be of the proper type, placed in critical locations, and installed properly. Valid readings depend on techniques and procedures used in installing and observing the instrumentation. For this reason, specialists experienced in field instrumentation should plan and supervise the field installations. These specialists can be from the district and/or division office, from WES, or from firms specializing in installations of instrumentation of earth and rock-fill dams. This applies whether the instrumentation is furnished and installed by the Government or furnished and installed by the contractor. Because proper interpretation of instrumentation data is vital to the safety of the dam, the responsibility for collecting and reporting data to the Engineering Division should be carefully delegated. Installation and observations of instrumentation are discussed in paragraph 6-5; the general use of instrumentation is described in Appendix E and by Dunnicliff (1988).

2-4. Records and Reports

Construction records and reports are needed to document results of tests made to verify specification requirements and action taken to correct deficiencies and to provide a record describing the field conditions, modifications to plans and

specifications, construction procedures, sequence of operations, and the location and as-built dimensions of important features. These are necessary to evaluate claims made by the contractor based on changed conditions, or claims by the Contracting Officer that work performed does not meet contract requirements. Progress reports are also needed for the district office and to provide a basis for payments to the contractor for work accomplished. Inspectors must maintain a daily inspection report (or log), and a master diary must be kept by the Resident Engineer. The required content of these documents is outlined in EM 415-1-302, "Inspection and Work Records." Details of specific construction control records and reports are described in Chapter 7.

a. Construction records. These records provide useful data for designing future alterations and additions to the structure, determining causes of later undesirable movement or seepage, or interpreting piezometric data. As-built drawings, construction photographs, descriptions of foundation conditions encountered and various treatments, compaction data, and test data on record samples should be included in the records.

b. Construction reports. The construction foundation report should include details such as dip and strike of rock, faults, artesian and other groundwater conditions, and other characteristics or conditions of foundation materials. A complete history of the project in narrative form should be written, giving the schedule of starting and completing various phases of the work, describing construction methods and equipment used, summarizing quantities of materials involved, and including other pertinent data. Foundation reports should be supplemented by photographs that clearly depict foundation conditions. Routine photographs should be taken at regular intervals, and additional pictures should be taken of items of specific interest, such as the preparation of foundations and dam abutments. For these items, colored photographs should be taken to provide a better depiction of construction conditions. The captions of all photographs should contain the name of the project, the date on which the photograph was taken, the identity of the feature being reported, and the location of the camera. In reports containing a number of photographs, an alternative would be an index map with a circle indicating the location of the camera with an arrow pointing in the direction the camera was pointing, with each location keyed to the numbers on the accompanying photographs. Details concerning the use and preparation of construction foundation reports are presented in ER 1110-1-1801.